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GENE ACTION FOR GRAIN YIELD AND ITS ATTRIBUTES OVER ENVIRONMENT IN SORGHUM (*SORGHUM BICOLOR* (L.) MOENCH)

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ABSTRACT

Using combining ability studies on line x tester analysis in sorghum revealed non-additive gene action for all the traits. Environments played important role in the expression of gca and sca variances. The female parents (testers) AKMS-14A and SUMS-1A and among males (lines) SU-893, S-248, SU-906, SU-912, SU-923, SU-934, SU-941 and SU-678 were good general combiners for grain yield and its components. While considering the sca effects and *per se* value, 16 hybrids were best for grain yield and component characters. All these hybrids were combination of either high x low or high x high gca parents for grain yield.

Key words : Sorghum, line x tester, combining ability, environmental effect, gene action.

The aim of plant breeder is to identify parents that will combine well and produce productive progenies. Since the quantitative traits are considerably influenced by the environments, a multi environmental study is likely to bring out genotype-environment interaction for estimating the gene effects precisely and predicting the advance under selection. General combining ability is good estimate of additive gene action, whereas specific combining ability is a measure of non-additive gene action (Rojas and Sprague, 1952; Sprague and Tatum, 1948). The present study has been carried out over four environments to know the type of gene action governing grain yield and its component traits and to identify parents and hybrids which could be exploited in future breeding programme.

MATERIALS AND METHODS

Twenty five male parents (lines) and 3 female parents (testers) exhibiting a wide spectrum of variation for different plant characters were mated in line x tester design during *kharif* 2000 to generate a total of 75 hybrids. These 75 hybrids with 28 parents and four checks *viz.*, CSH-6, CSH-14, CSH-9 and CSH-5 were planted in randomized block design with three replications in four environments viz., E_1-[recommended spacing (45 x 15 cm) alongwith recommended dose of fertilizer (80 kg N/ha)], E_2- [recommended spacing (45x15 cm) alongwith half dose of fertilizer (40 kg N/ha)], E_3- [30 x 7.5 cm spacing alosng with recommended dose of fertilizer (80 kg N/ha)] and E_4- [30 x 7.5 cm spacing alongwith half dose of fertilizer (40 x N/ha)] in *kharif* 2001 at R.C.A., Udaipur. The data were recorded on yield and yield contributing traits on ten randomly selected competitive plants except days to flowering and maturity which were recorded on plot basis. The combining ability analysis for line x tester mating design was conducted as per the procedure described by Singh and Choudhary (1995).

RESULTS AND DISCUSSION

The pooled analysis of variance for combining ability revealed that mean squares due to lines, testers and line x tester were significant for all the traits under investigation, thereby suggesting that the experimental material possessed considerable variability and that both gca and sca were involved in the genetic expression of grain yield and other component traits. Saxena *et al.* (1999) and Birader *et al.* (2000) also reported similar results. The higher values

Table 1. Analysis of variance for combinig ability pooled over environments

S. No.	Source	d.f.	Mean square									
			Days to 50% flowering	Days to maturity	Stover yield /plant	Panicle length	Whorls of primarics/ panicle	Primaries/ panicle	Test weight	Harvest index	Grain yield /plant	Protein content
1	Environment	3	218.36**	88.634**	4.4622e+05	269.39**	193.8**	1191.9**	3318**	483.53**	2.358e+05**	0.689**
2	Rep./Env.	8	1.447*	0.719	16.085	3.534*	1.378*	13.935*	15.11**	1.926	13.818	0.093
3	Genotype	106	456.67**++	870.83**++	6696.5**++	191.36**	21.491**	1059.4**	112.74**	238.04**++	2115.4**++	11.496**
	Check	3	373.97**	126.92**	1025.2**+	116.03**	10.354**	145.08**	33.757**	184.62**	1229.5**++	0.899**
	Pv/s chk	1	1836.8**	6324.1**	118.93	792.68**	32.595**+	11087**	210.05**++	26.974	1271.6**	0.139
	Parent	27	297.85	1665.7**	6190.9**++	152.78**	22.803**	1814.2**++	103.9**++	285.42**++	1596.4**++	18.474**
	Tester	2	756.78**++	402.53**	724.22**	5.89**	6.861**	226.33**	125.62**	119.99**	228.26**	4.351**
	Line	24	195.9**++	1600.4**++	4051**	170.14**++	24.965**++	1765.6**	105.03**++	232.41**	1104.2**	18.556**++
	Tv/s L	1	1826.8**++	5759.1**	68482**	30.036**	2.786*	6156.8**	33.332**	1888.4**++	16147**++	44765**
	Pv/s H	1	18481**	40583**++	47883**	4342.3**	101.12**	876.6**	2077**++	10.711	31820**++	59.721**
4	**Hybrid**	74	280.52**	80.885**++	6599.7**++	153.96**	20.571**	699.77**	94.136**++	228.94**++	1963**++	8.774**++
	Tester	2	8000.9**++	242.94**	87752**++	266.77**	59.834**	6068.2**	1440.7**++	74.889**	29977**++	32.553**
	Line	24	86.762**++	92.104**	6592.6**++	143.63**	25.145**	600.5**	79.855**++	260.39**++	958.85**++	8.534**
	LxT	48	55.718**++	68.523**	3222**++	154.42**	16.648**	525.72**	45.168**++	219.63**++	1297.8**++	7.902**
5	**GxE**	318	1.965**	5.133**	1127.3	0.662	0.613	3.234	5.658**	61.759	329.09**	0.0097
	ChxE	9	0.854	1.305	260.29*	0.716	0.539	0.78	2.468	49.228**	163.91**	0.004
	Pv/s chikxE	3	1.481	1.522	35.98.6**	0.155	1.739*	3.545	3.663	14.073	129.55*	0.004
	PxE	81	0.691	17.445**	1345.8**	0.951	0.609	2.104	4.514**	46.995**	224.91**	0.028
	TxE	2	2.666*	0.805	212.85	3.538	1.138	6.111	9.43**	18.932	186.03**	0.001
	LxE	24	1.875**	58.707**	3428.1**	2.889	1.722**	6.427	13.614**	153.2**	566.45**	0.094**
	TV/SLxE	3	1.889**	0.824	877**	0.223	1.93*	1.341	6.683**	30.62*	1417**	0.013
	PV/SHxE	3	1.464	9.238**	121.87	2.275	0.138	5.231	23.562**	256.87**	758.75**	0.017
	HybridxE	222	2.494**	0.806	1063.8**	0.540	0.605	3.695	5.875**	65.658**	366.9**	0.003
	TxE	6	3.989**	2.722	9677.6**	0.494	0.584	2.286	27.189**	303.31**	4790**	0.002
	LxE	72	3.133**	0.673	999.77**	0.404	0.620	2.732	4.577**	41.842**	215.34**	0.003
	LxTxe	144	2.112*	0.793	763.86**	0.610	0.598	4.235	5.635**	67.663**	258.38**	0.003
6.	**Pooled error**	848	0.630	1.446	126.35	1.272	0.579	5.836	1.396	9.816	35.746	0.047
							Effect					
	ΣGCAT		53.335	1.61	584.17	1.77	0.39503	40.416	9.5956	0.43382	1.9961	0.2167
	ΣGCAL		57.421	60.439	4310.8	94.904	16.377	396.44	52.306	167.05	615.4	5.6579
	ΣGCA		220.35	268.31	12382	612.6	64.273	20793	175.09	839.27	5048.3	31.42
	ΣGCA TxE		0.26875	0.10212	764.1				2.0634	23.479	380.34	
	ΣGCALxE		20.027	-6.1839	6987.4				25.449	256.2	1436.8	
	ΣSCA x E		71.141	-31.337	29304				203.51	2776.2	10686	

*,** Significant at 5% and 1% level of singnificance, respectively.

Table 2. Hybrid conbinations with desired significant sca effects for gain yield together with *per se* performance in L x T analysis in sorghum

Hybrid (s)	*Per se* performance g/plant	sca effects for grain yield	gca effects of parents for grain yield	Type of combination
SUMS-1AxSU-923	94.21**	13.13**	SUMS-1A=3.45** SU-923=9.93**	high x high
SUMS-14AxSU-885	87.97**	18.36**	SUMS-1A=3.45** SU-885=-1.54	high x low
SUMS-1AxSU-678	86.28**	12.60**	SUMS-1A=3.45** SU-678=2.53*	high x high
AKMS-14AxSU-912	85.97**	4.57*	AKMS-14A=7.82** SU-912=5.87**	high x high
AKMS-14AxSU-905	86.77**	8.75**	AKMS-14A=7.82** SU-905=1.50	high x high
AKMS-14AxSU-915	85.18**	11.10**	AKMS-14A=7.82** SU-915-1.44	high x high
AKMS-14AxSU-888	83.98**	8.29**	AKMS-14A=7.82** SU-888=0.17	high x high
SUMS-1AxSU-912	82.43**	5.40**	SUMS-1A=3.45** SU-912=5.87**	high x high
SUMS-1AxSU-941	81.85**	7.10**	SUMS-1A=3.45** SU-941=3.60**	high x high
AKMS-14A x SU-556	80.68**	10.41**	AKMS-14A = 7.82** SU-556 -5.25**	high x high
SUMS-1A x SU-893	79.89**	6.71**	SUMS-1A = 3.45** SU-893 = 2.03*	high x high
AKMS-14A x SU-921	79.75**	4.24*	AKMS-14A = 7.82** SU-921 =-0.01	high x high
SUMS-1A x SU-937	77.62**	12.00**	SUMS-1A = 3.45** SU-937 = -5.52**	high x high
SUMS-1A x SU-922	73.61**	5.76**	SUMS-1A = 3.45** SU-922 = 3.30**	high x high
AKMS-14A x SU-931	73.32**	5.70**	AKMS-14A = 7.82** SU-931 = -7.89**	high x high

*, ** Significant at 5% and 1% level of significance, respectively.

of $\sum$ SCA than both of $\sum$ GCAT and $\sum$ GCAL for all the traits in all environments indicated the importance of non-additive variances in control of all the characters studied. This shows the possibilities of improvement of these traits through heterosis breeding. Similar non-additive gene action and its importance was also reported by Senthil and Palanasamy (1994) and Bhavsar and Borikar (2002). Both gca and sca influenced by environments suggesting that to have unbiased estimate of gca and sca, the material may be tested over wide range of environments (Table 1).

Genotypes with significant gca effects in desired direction are expected to transmit genes with desirable effects to their progeny. Two testers and 8 lines for grain yield per plant, one tester and 10 lines for stover yield per plant, one tester nine lines for test weight and harvest index, one tester and 12 lines for panicle length, one tester and 10 lines for whorls of primaries per panicle, 2 tester and 9 lines for primaries per panicle, one tester and 11 lines for days to 50% flowering and one tester and 9 lines for days to maturity showed desired significant gca effects for the respective traits in pooled analysis over the environments. Among the testers AKMS-14A and SUMS-1A were good general combiners for most of the characters observed. Among the lines on the basis of grain yield per plant eight lines viz, SU-893, SU-248, SU-906, SU-912, SU-923, SU-934, SU-941 and SU-678 were good general combiners alongwith more than one of its component traints in pooled analysis. Eventhough, none of the parents was a good combiner for all the attributes. Obviously these lines may be used in conventional breeding programmes employing simple pedigree method or more potent methods like recurrent selection using biparental or diallel selective matting to concentrate more additive genes thereby enhancing the performance. The performance of the parents and their gca effects varied in different environments which may be attributed to genotype x environment interaction.

The hybrids showing desired significant sca effects for grain yield per plant along with one or more yield component traits in pooled analysis are listed in Table 2. In this study 26 hybrid each for grain yield and stover yield per plant, 25 each for test weight and protein content, 27 for panicle length, 21 for whorls of primaries per panicle, 28 for primaries per panicle, 22 for arrest index, 12 for plant height and 28 for days to 50% flowering revealed significant desired sca effects for these traits in pooled over the environments. Among the hybrids AKMS-14A x SU-905, SUMs-1A x SU-885 and SUMS-1A x SU-937 were the best specific combinations for grain yield and its components and they exhibited desired significant sca effects for maximum number of traits with high yield and involving high x low gca parents. The hybrids AKMS-14A x SU-888, AKMS-14A x SU-556, AKMS-14A x SU-913, AKMS-14A x SU-915, AKMS-14A x SU-921, AKMS-14A x SU-931 and SUMS-1A x SU-922 are important as they showed significant desired sca effects for grain yield, stover yield and at least for one yield contributing component. These hybrids also involved high x low gca parents for grain yield. These results indicated that the hybrids with superior sca effects involving high gca parents could be exploited to yield positive heterosis in higher frequencies. The same results were reported earlier by Iyanar *et al.* (2001).

Six hybrids viz., AKMS-14A x SU-912, SUMS-1A x SU-893, SUMS-1A x SU-912, SUMS-1A x SU-923, SUMS-1A x SU-941 and SUMS-1A x SU-678, exhibited desired sca and gca effects, high *per se* performance and involved high x high gca parent combination (Table 2). Parents with high x high gca effects for grain yield alongwith one or the other component trait indicates presence of additive x additive type of gene action between favorable allele contributed by the two parents, which is fixable. These results are in conformity with the findings of Subba Rao and Aruna (1997).

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